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INTERDISCIPLINARY APPLICATIONS AND INTERPRETATIONS OF

ERTS DATA WITHIN THE SUSQUEHANNA RIVER BASIN

Resource Inventory, Land Use, Pollution

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ERTS Investigation 082

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I. ACCOMPLISHMENTS

Preparation and presentation of papers at the ERTS Symposium held at GSFC on March 5-9, 1973, constituted much of the work during this reporting period. Papers presented and the authors were:

1. "Analysis and Application of ERTS-1 Data for Regional Geological Mapping", D. P. Gold, R. R. Parizek, S.A. Alexander.
2. "The Use of ERTS-1 MSS Data for Mapping Strip Mine and Acid Mine Drainage in Pennsylvania", S. S. Alexander, J. Dein, D. P. Gold.
3. "Investigations of an Urban Area and its Locale Using ERTS-1 Data Supported by U-2 Photography", H. A. Weeden, F. Y. Borden, D. N. Applegate, N. Bolling.
4. "Mapping of Agricultural Land Use from ERTS-1 Digital Data", A.D. Wilson, G. A. May, G. W. Petersen.
5. "Identification and Mapping of Coal Refuse Banks and Other Targets in the Anthracite Region", F. Y. Borden, D. N. Thompson, H. M. Lachowski.
6. "Classification of ERTS-1 MSS Data by Canonical Analysis", H. M. Lachowski, F. Y. Borden.

The ORSER system for processing digital MSS data is now being used on a daily basis by a non-university user for the first time. The MITRE Corporation has subcontracted for services by ORSER personnel and systems with applications to ERTS data analysis. Though the analytical results of this analysis are primarily reported by MITRE, an important result from the standpoint of ORSER's contract with NASA is the demonstration of the ease and efficiency with which MITRE personnel have used the ORSER data processing system via long distance telephone lines. The digital tapes are mailed to ORSER where they are subsetted and stored. MITRE personnel then simply request the mounting of the desired tape and operate on it using ORSER programs, or any modification thereof which the user may wish to make. Analytical results are then produced at the MITRE terminal and/or stored in the user's file at Penn State. No operating difficulties have been encountered.

A new mosaic of the state of Pennsylvania was constructed from ERTS imagery. The ERTS scenes used to make this mosaic are:

10 OCT 72	1079-15124	7 SEP 72	1046-15292
10 OCT 72	1079-15131	7 SEP 72	1046-15295
10 OCT 72	1079-15133	7 SEP 72	1046-15301
11 OCT 72	1080-15183	7 SEP 72	1046-15304
11 OCT 72	1080-15185	1 NOV 72	1101-15354
6 SEP 72	1045-15240	21 AUG 72	1029-15352
6 SEP 72	1045-15243	21 AUG 72	1029-15354
1 AUG 72	1009-15244		

A summary of progress to date and current work is given below. This summary is organized according to the task descriptions in the proposal submitted for this project.

1. Inventory of Natural Resources and Land Use

A. Identification and characterization of soil parameters

An area in Lancaster and Lebanon Counties, Pennsylvania has been investigated with computer classification results clearly distinguishing sandstone ridges, limestone valleys, drainage patterns and some cultural features. Due to the nature of the terrain in that geographical area and consequent small and irregular agricultural fields, determination of soil patterns from ERTS data is largely dependent upon correlation with the classification results mentioned above. Aircraft data has been highly useful in this task. Areas with larger agricultural fields are now being investigated for soil classification purposes. In addition, ERTS data collected in the spring of 1973 is expected to be more useful for soil classification.

B. Location, inventory, and monitoring of strip mining operations and pollution spoils

(1) Digital processing of ERTS-1 MSS data for areas near the West Branch of the Susquehanna River has resulted in identification of stripped areas including ones that are not discernible from visual analysis of ERTS imagery. Underflight data and ground truth are used as a basis for making sub-classifications of stripped areas, particularly with regard to manifestations of acid mine drainage. Results to date indicate that ERTS can be used to monitor the extent of stripping and also the effectiveness of reclamation.

(2) ERTS-1 MSS data covering parts of Pennsylvania's Southern and Eastern Middle Anthracite Coal Fields has been used to identify and map accumulations of coal refuse using computer processing and analysis. Mapping the location and areal extent of coal waste material has been shown to be feasible, and as more ERTS data is received the temporal changes will be monitored by producing updated maps.

C. Survey and inventory of forest resources

Digital MSS data has been used for the detection, classification, and mapping of four categories of vegetation; (1) open area covered with herbaceous vegetation; (2) open areas covered with brushy vegetation; (3) areas forested with deciduous trees; and (4) coniferous vegetation. An area including state game and forest lands near the Kinzua Dam in northwestern Pennsylvania near the city of Warren has been chosen for investigation. Preliminary results are promising and use of U-2 imagery over the test site is expected to result in more detailed classification and mapping.

D. Collection and updating of data for multipurpose land use management

An urban area in central Pennsylvania and the surrounding locality were investigated by photointerpretive and computer analysis methods, both separately and combined. Categories of water, forest, high density suburbs, industrial, parking lots, and concrete were reasonably well defined and classified. Agricultural fields, highways, and low density suburbs require more study. Some categories may not be obtained because of size or low subject-to-background contrast. The temporal aspect of the data for land use mapping is also being investigated.

E. Development of natural resource inventory systems

ORSER has discussed with the Pennsylvania Department of Environmental Resources the potential use of remote sensing data in a natural resource inventory and land use management system to be called PENNRALI. This system will include other types of related information, but ORSER will provide technical assistance for data formats, categories, etc., as related to remote sensing data.

2. Geology and Hydrology

A. Characterization and analysis of geologic structures and terrain

Combined visual and digital techniques are used to analyze ERTS data for geologic information in Pennsylvania. Supervised mapping

of parts of eastern Pennsylvania has delimited the Diabase Sills and the Precambrian rocks of the Reading Prong with remarkable accuracy. Unsupervised mapping yielded transgressive linear features in unexpected density. These features exhibit strong control over river valley and stream channel directions. Comparison has been made of the orientation and length of lineaments in two areas east and south of Harrisburg on the southern limit of the Appalachian fold flexure. With ground mapping and underflight data six scales of linear features have been recognized. Work has just commenced on evaluation of the geology and structure in the Pittsburgh area using ERTS imagery. A "long lineament" map of Pennsylvania has been constructed. A tectonic map of the state will be developed next. The Pennsylvania Geological Survey will provide existing structural data for assistance in this project.

B. Inventory of mineral resources and mines

Using ERTS imagery, close correlation has been observed between metallic ore deposits and the Mt. Union-Tyrone(Pa.) lineament. Five metallic sulfide deposits are known to be located along this lineament and the bedrock conditions are currently being investigated. U-2 underflight photography along this feature has been requested. In the Ebensburg, Pa., area, an investigation is being conducted to determine the quality of coal and mining conditions relative to short lineaments observed on the ERTS imagery.

C. Detection of ground water sources from drainage, lineaments, and fracture patterns.

Locations of known ground water sources are being correlated with fracture traces and lineaments observed on ERTS imagery. Success to date indicated that ERTS data will be a highly productive source of information for fracture trace mapping on a regional scale for ground water exploitation.

3. Pollution

A. Monitoring the environmental effects of power generating plants

The Three Mile Island nuclear power plant near Harrisburg, Pa., has been selected for this investigation. ERTS imagery has been examined, aircraft underflight data has been obtained, and ERTS digital data has been processed and classified for this area. Since this plant is in final stages of construction, it is expected to go "on line" soon and ERTS data will provide coverage of the area both before and after the plant becomes operational.

B. Detection of sources of acid mine drainage

Digital processing of ERTS MSS data for areas along the West Branch of the Susquehanna River has identified surface areas affected by acid mine drainage. These areas could not be identified by visual analysis of ERTS imagery.

C. Detection of air pollution damage

Detailed work on this project has just commenced. It is anticipated that data from ERTS passes in the spring and early summer of 1972 will be more appropriate for analysis of this type.

4. Use of Remotely Sensed Data to Compliment Studies of Atmospheric Effects

Work has not commenced on this project. The position of State Climatologist (who was to have performed this work as part of his duties and without NASA funding) has been abolished and no replacement is anticipated.

5. Data Processing

A. Data processing and pattern recognition techniques applied to ERTS data

ORSER has developed and is using an operational system for processing of both imagery and digital tapes. A standard digital tape format was designed within which all known MSS sources (ERTS, EREP, aircraft) can conveniently be placed. Computer programs in use include statistical analyses, preprocessing, pattern recognition and classification, and map print-outs. Photointerpretive techniques are continually applied to ERTS imagery and to photography from U-2 and C130 aircraft flights. Computer differentiation of areas from scanner data is far superior to that done by the human eye, but the photointerpreter is essential, as an integral part of the data processing, for providing identification and interpretation of features exhibited on computer output. As a not unexpected result of preliminary ERTS analysis, ORSER stringly feels that a hybrid approach to data processing is essential.

B. Use of machine-aided image analysis

This task involves the use of General Electric Company equipment located at Valley Forge, Pa. It was decided not to initiate this task until the second year of the contract in order that: (1) ORSER personnel would have a better understanding of the use of ERTS data and the potential use of the GE equipment; and (2) the equipment would have been updated and GE personnel would be better able to suggest efficient and effective ways of using the equipment.

II. AIRCRAFT SUPPORT

Both U-2 and C-130 aircraft photography is used in the ERTS analysis. ORSER uses this information primarily as ground truth. ORSER has received and will soon commence processing digital data from NASA Houston for MSS data collected simultaneously with the photography. The MSS data will also be used for ground truth and in addition, be compared to ERTS data for evaluation of scale, resolution, and distortion effects. Dr. Gary Petersen of ORSER attended a conference at NASA MSC (Houston) on February 26, 1973. This conference was called by the Aircraft Application Branch to discuss various aspects of data acquisition and processing using the 24-channel MSS.

A set of maps is attached as Appendix A. The maps show the NASA aircraft flight lines on which data was collected and is available to ORSER for support of this ERTS project.

III. EQUIPMENT

A new high intensity light table has been ordered using general University funds provided to ORSER by the Space Science and Engineering Laboratory (SSEL). This table will permit better viewing of color ERTS transparencies.

The Bausch and Lomb Transferscope, which was ordered in December, is now scheduled for delivery in June 1973. This late delivery will slow some of the hybrid analysis which utilizes both imagery and computer print-outs simultaneously.

IV. PUBLIC RELATIONS ACTIVITY

As a result of the announcement by Governor Shapp of the submission of an ERTS-B Proposal by the Commonwealth of Pennsylvania, ORSER received several inquiries regarding ERTS-1 activities. Local radio and television interviews of ORSER personnel were aired, a university class in community development visited ORSER, and various other expressions of interest were received (including one seeking information regarding bird sanctuaries).

V. SEMINAR

A continuing seminar was held during January-March, 1973. The purpose of this seminar was to: (1) permit all co-investigators an opportunity to present the many facets of work being conducted on this project; (2) provide a forum for discussion and increased interdisciplinary activity within ORSER; (3) introduce non-ORSER personnel to the potential uses of remote sensing; and (4) provide an educational opportunity for students interested in remote sensing. The

seminar was very successful and a continuation of the seminar is planned for April and May. (The seminar is scheduled to conform with the academic terms at The Pennsylvania State University.) A list of the seminar topics is given below.

SEMINAR ON REMOTE SENSING

WINTER TERM 1973

Date	Topic	Speaker
Jan. 12	The ERTS-1 Sensing Systems	G. J. McMurtry
Jan. 19	The Storage and Viewing of ERTS Imagery and Underflight Photos and Scan Data	Nanna Bolling Harmer Weeden
Jan. 26	A Detailed Look At Multispectral Scan Images and Factors Affecting Their Quality	Harmer Weeden F. Yates Borden
Feb. 2	The Need for and Use of Underflight Data (Photo and Tape)	G. W. Petersen
Feb. 9	Automatic Data Processing Techniques	F. Yates Borden B. Turner
Feb. 16	Progress Report on Combined Techniques Interpretive and Computer	F. Yates Borden D. Gold H. Weeden
Feb. 23	How to Talk to the Computer (and get an answer)	F. Yates Borden
Mar. 2	ERTS Applications in Agriculture	◦ G. W. Petersen
Mar. 9	ERTS Applications in Geology	S. Alexander D. Gold R. Parizek
Mar. 16	ERTS Applications in Engineering	H. Weeden

VI. RELATED ACTIVITIES

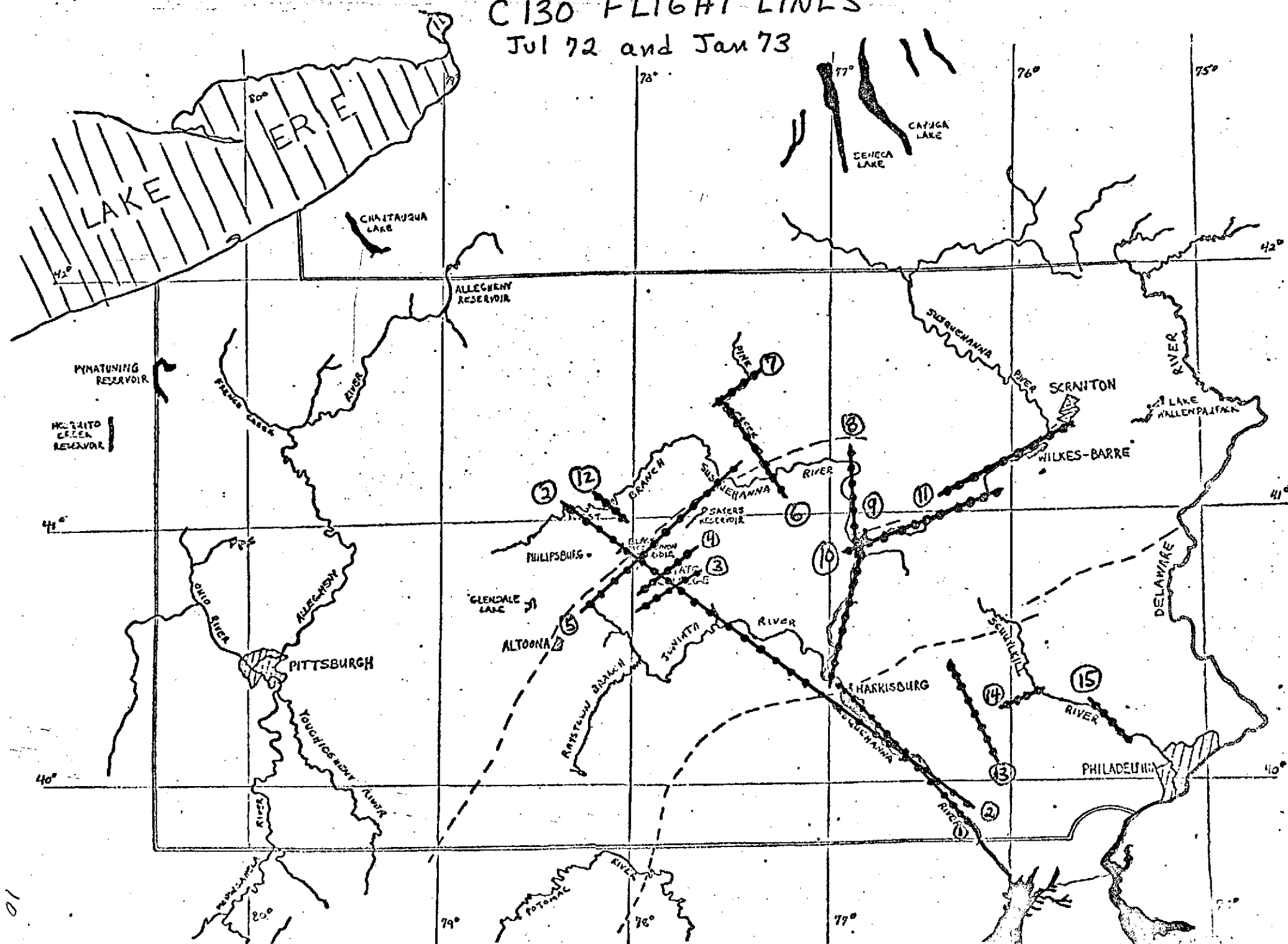
Dr. George McMurtry attended a meeting at NASA Wallops in February between personnel from NASA and the Marine Science Consortium. The purpose of the meeting was to seek potential applications of remote sensing to problems in or near Chesapeake Bay. Potential use of ORSER's data processing system was considered. A proposal is being prepared by the Consortium to NASA for such a project involving both Consortium and NASA personnel.

A contract with the U.S. Army Corps of Engineers for a remote sensing floodplain feasibility study on the West Branch of the Susquehanna River is being finalized.

APPENDIX A

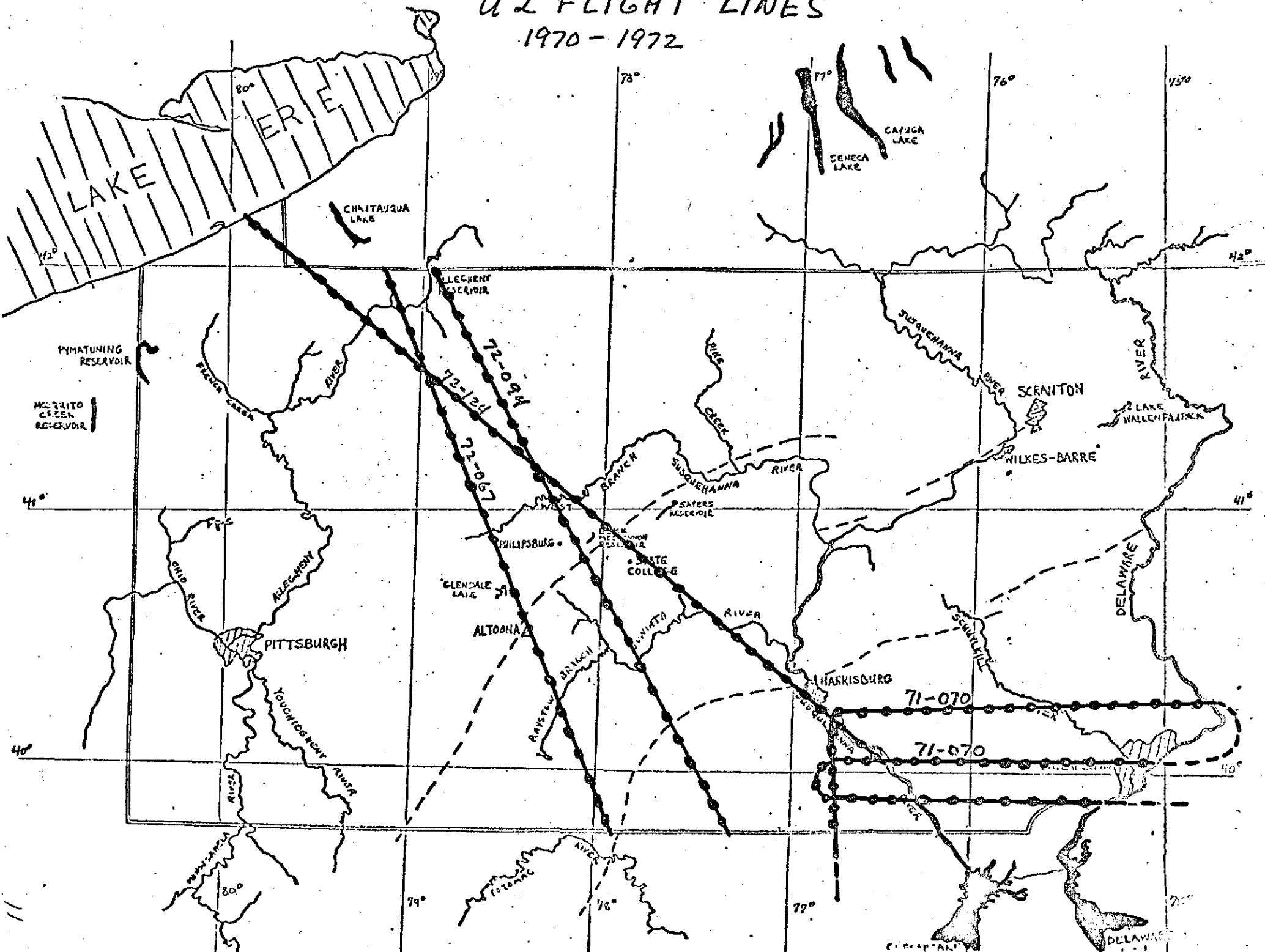
C130 FLIGHT LINES

Jul 72 and Jan 73



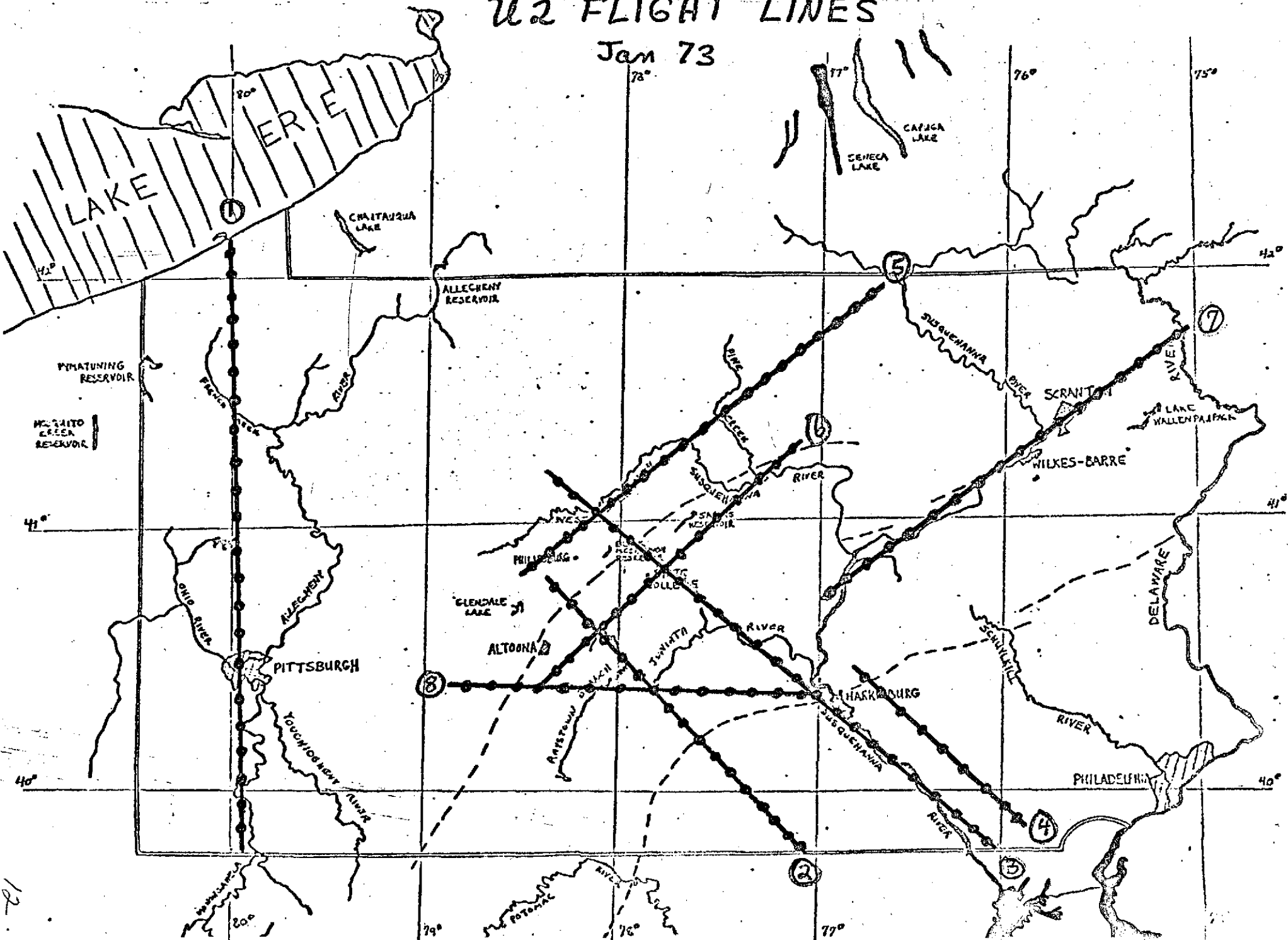
U2 FLIGHT LINES

1970-1972



U2 FLIGHT LINES

Jan 73



C 54 FLIGHT LINES

Jan 73

